CHAPTER 9
OPERATION AND MAINTENANCE

9-1. General operation and maintenance

Effective operation and maintenance (O&M) management is critical to obtaining the designed levels of reliability and performance of utility systems in any C4ISR facility. In a facility based on the LVD concept, O&M procedures must account for and maintain the independence of peripheral zone utility systems as well as provide effective concurrent maintenance of the systems within the command center.

a. A critical component of required O&M for facilities using the LVD concept is a sensor calibration program. Survivability of the command center depends on prompt detection of threat conditions, which for CBR threats is highly dependent on accurate sensor operation.

b. Failure to detect an event may result in compromised ventilation supply to the command center; detecting an event where none exists (nuisance alarm) results in unnecessary isolation of the command center from a source, reducing the redundancy of its supplies, which may negatively impact reliability and availability.

9-2. Applicable codes and standards

The primary references for O&M of C4ISR facilities are the following:

a. TM 5-692-1, Maintenance of Mechanical and Electrical Equipment at Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) Facilities – Recommended Maintenance Practices.

b. TM 5-692-2, Maintenance of Mechanical and Electrical Equipment at Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) Facilities – System Design Features.

c. TM 5-698-2, Reliability-Centered Maintenance (RCM) for Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) Facilities.

9-3. Maintenance scheduling

The minimum N+2 redundancy criterion described in chapter 2, Fundamentals of Limited Vulnerability Design, is intended to provide the O&M staff with the flexibility to schedule downtime for the utility systems in a single zone without compromising the facility's ability to meet the mission RAM criteria. Care should be taken to prevent scheduled outages from affecting systems in more than one zone unless it can be demonstrated that there is no interdependency between the affected systems; for example, it may be permissible to shut down a heating pump in Zone 1 and a cooling pump in Zone 2, but only if there are no control interfaces between the heating and cooling systems that would allow work on one system to impact the availability of the other.

9-4. Periodic testing

As described in chapter 8, Commissioning, the ability of the mission-critical zone to survive an event in a peripheral zone depends on the proper function of the devices and associated controls that serve to isolate the mission-critical zone's utility systems from the compromised zone. This capability should be periodically verified through an integrated system test (also referred to as a "pull-the-plug" test). Such a test should simulate the worst-case event that the systems are designed to survive. In the case of the example facility, that event would be simultaneous loss of outside utilities and one zone's mechanical and electrical systems while a utility system in another zone is out of service. A test plan should be developed for the facility. The plan should identify the detailed requirements and frequency for periodic testing.

9-5. Spare parts stocking

Many factors should be taken into consideration for stocking spare parts. Some of the primary considerations are quantity, location, and storage containment.

a. Determine the on-site spare parts stocking levels for utility systems and equipment based on the manufacturers' recommendations, equipment criticality, mission time, and component reliability data.

b. In addition to providing an adequate parts supply to maintain the required operational availability, consider the LVD concept in selecting the means and location of spare parts storage.

c. Distribute parts among the zones and store them in proximity to the equipment with which they are to be used to prevent a single threat event from affecting all spare parts of a particular type.

d. If space permits, stock critical parts for zone utility equipment in the command center zone to protect them from loss due to peripheral zone events.

e. Store parts that could be damaged by environmental, radiation, or electromagnetic exposure in suitable enclosures or cabinets.

9-6. Disaster recovery

A C4ISR disaster can be defined as an unplanned occurrence or event that results in an inability to support a mission within the current environment. Such an event can be caused by natural (geological or meteorological), accidental (human- or equipment-caused), or intentional (terrorist) actions. Because it is paramount that a critical mission continue after a disaster occurs, on-site management should prepare by developing a disaster recovery plan, which provides contingency guidelines for continued operations (continued mission) after a disaster occurs.

a. Recovery plans, developed for any number of potential scenarios that can affect operations, require careful preparation. If need be, mock disaster scenarios can be "played out" to identify weaknesses in the plan, which can be amended to correct for disparities. Appendix A, References, includes a comprehensive list of guidance and documentation necessary for preparing recovery plans and related site recovery activities.

b. In the event that a disaster recovery plan is not available for the facility, site management should, at a minimum, develop a disaster recovery responsibility matrix. While not a substitution for a complete recovery plan, this matrix provides some guidance for coordinating the continued operation after a disaster occurs. As a starting point, appendix E, Disaster Recovery, provides a matrix that includes a key listing of potential disasters (Potential Disaster Scenarios) aligned with suggested primary site contacts and affected areas within the C4ISR installation. By identifying the disaster scenario and affected site, the reader can identify the primary contact person responsible for coordinating first response efforts. Some scenarios may not directly affect a specific site within the installation but result in issues that indirectly impact operations.

c. For example, biological hazards (key item C) will not directly impact the operation of a power generator but may result in personnel not being available to maintain the power-generating equipment. Primary coordination with medical personnel will identify this issue. Medical personnel can then review the situation with the secondary response person (Facility Manager), who can make adjustments to operations to compensate for the lack of personnel in the maintenance function.